A Double Moon.

ON December 22, a well-defined double moon was seen 7m. before sunrise, which is here now at about 7. The fictitious moon was as a disk of white glass, through which the under-lapping part of the true moon could be seen. Atmospheric conditions being similar next morning, I watched for a repetition of the phenomenon, but after some abortive efforts, consisting of repeated, momentary, ill-defined projections of the moon's shape at a distance of three times the space occupied by her diameter, it was finally "given up." ROSE MARY CRAWSHAY.

Mentone, Hotel du Louvre, December 30, 1891.

ON THE RELATION OF NATURAL SCIENCE TO ART.[1]

II.

THERE is yet another direction in which art owes instructive disclosures to the progress of photography. In the year 1836, the brothers William and Edward Weber represented, in their celebrated work on the "Mechanism of the Human Locomotive Apparatus," a person in the act of walking, in those attitudes which, according to theoretical calculation, must occur successively during one step. Thence a strange fact became apparent. At the beginning and end of each step, while the body rests for a short time on both feet, the pictures agree perfectly with the ordinary way in which painters have been accustomed to represent walking persons. But during the middle of the step, while one foot is swinging past the other, the effect is highly eccentric, not to say ludicrous; the individual appears to be stumbling over his own feet like a tipsy fiddler, and nobody had ever been seen walking in such a way. On the last page of their book, the brothers Weber propose to test the correctness of their diagrammatic figures by the aid of Stampfer and Plateau's stroboscopic disks, in the shape of Horner's Dædaleum,[2] which has, strange to say, returned to us from America as a new invention, under the name of "zoëtrope" or even "vivantoscope"; but whether the proposal was carried out or not, does not appear.

However, William Weber lived to see his assertions thoroughly justified almost half a century later by instantaneous photography. It was first put into practice in 1872 by Mr. Eadweard Muybridge at the suggestion of Mr. Stanford, in order to fix the consecutive attitudes of horses in their different paces. The result was the same as in Weber's diagrammatic figures; pictures were obtained which nobody could believe to have seen in reality. On photographs of street life and processions the camera frequently surprised people in attitudes quite as odd as those attributed to them by the brothers Weber on theoretical grounds. The same is the case with the remarkable series of photographs of a flying bird during one beat of its wings, obtained by M. Marey with his photographic gun.

The explanation is known to be as follows: An object in motion, the speed of which varies periodically, leaves a deeper and more lasting impression on our mind in those positions which it occupies longest, while the impression is fainter and more fleeting in those through which it passes quickly. Apart from all knowledge of this law, a painter would never represent a Dutch clock in a cottage with the pendulum at the perpendicular, as every spectator would inquire why the clock had been stopped. The pendulum, having swung in one direction, necessarily stops for a moment while preparing to return in the other, and consequently its diverging position is more vividly stamped on our minds than those during which it passes through its position of rest with a maximum of speed. Precisely the same thing occurs with the alternately swinging legs of a man during the act of walking; the body remains longest in the position in which both feet support it, and shortest in that during which one foot swings past the other. We therefore receive scarcely any impression from the latter series of attitudes. We imagine a walking person, and painters accordingly represent him, in the interval between two steps, with both feet touching the ground.

In the case of a running horse, however, particular circumstances intervene. However rapid the succession of instantaneous photographs, we never obtain the usual image of a racing horse such as it appears in large numbers in the print-shops at the racing season, and such as we suppose we actually see in reality. It is different in the case of man; there among pictures obtained methodically or by chance, which have, so to speak, never been perceived by the naked eye, some will always occur which agree with the usual aspect of a walking person. The difference consists in this, that in a racing horse the interval of time, during which the fore-legs remain in complete extension, does not coincide with that during which the hind-legs are fully extended. Both these positions prevailing in our memory, they are subsequently blended into the traditional picture of a racehorse, whereas instantaneous photography fixes them successively. Consequently the traditional picture is wrong, and exhibits the horse in a position through which it does not even transitorily pass.

In the year 1882, an illustrated American paper brought out a picture of a steeplechase, in which all the horses are copied from Muybridge's photographs, in attitudes only visible to a rapid plate. This ingenious sketch was communicated to us by Prof. Eder in Vienna, in a pamphlet on instantaneous photography, and a stranger spectacle cannot well be imagined. The correctness of these apparently wrong pictures can, however, be proved by realizing the idea originally suggested by the brothers Weber, and integrating into a general impression the periodical motion which has been resolved, as it were, into differential pictures. This is done by gazing in the dædaleum at a series of photographs taken at sufficiently brief intervals from an object in periodical motion, or illuminating or projecting it momentarily during its rapid flight past the eye. The latter method has been put into practice by Mr. Muybridge himself in his "zoopraxiscope," and with us in the electric stroboscope by Mr. Ottomar Anschütz, a most skilful handler of instantaneous photography. In both instruments we see men and horses reduced to their natural mode of walking, running, or jumping—with one exception. The speed with which the slits of the dædaleum pass before the eye, or the period during which each picture is illuminated, being exactly the same for the whole series, the general effect produced is somewhat different from what it would be in real life. On the whole, however, the position in which both feet are touching the ground, prevails, because the motion of the legs slackens when approaching this position, so that the pictures follow each other more closely and almost coincide.

The series of instantaneous photographs taken by Mr. Muybridge and Mr. Anschütz from an athlete, during the performance of a muscular effort, are an inexhaustible source of instruction to students of the nude. Mr. Anschütz's stroboscope exhibits a stone- and a spear-thrower in all the different stages of their violent action: their muscles are seen to swell and slacken, until finally the missile is represented after its discharge, as it cannot move any faster than the hand in the act of hurling it.

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[1] An Address delivered by E. du Bois-Reymond, M.D., F.R.S., at the annual meeting of the Royal Academy of Sciences of Berlin in commemoration of Leibnitz, on July 3, 1890. Translated by his daughter. This Address was first printed in the weekly reports (*Sitzungsberichte*) of the Berlin Academy, then in Dr. Rodenberg's *Deutsche Rundschau*, and lastly it was published as a separate pamphlet by Veit and Co., at Leipzig, 1891. Continued from p. 204.

[2] *Philosophical Magazine*, January 1834, 3rd Series, vol. ii., p. 36.

Animal painters will find equally useful the instantaneous photographs which Mr. Muybridge and Mr. Anschütz have obtained from domestic and wild animals.

Even on breakers in a stormy sea the camera has been employed with surprising success. In making use of these photographs, painters should, however, remember that the human eye cannot see the waves as a rapid plate does, and beware of producing a picture which in certain respects would be quite as incorrect as the clock which appears to have been stopped, or the man stumbling over his own feet.

Finally, the traditional representation of lightning in the shape of a fiery zigzag has been recently proved by Mr. Shelford Bidwell, on the evidence of two hundred instantaneous photographs, to be just as wrong as the traditional picture of a racing horse. Mr. Eric Stuart Bruce endeavours to vindicate the zigzag by taking it for a reflection on cumulus clouds;[1] it is, however, difficult to understand how its sharp angles can be accounted for in this way.

Prof. von Brücke has devoted a special essay to the rules for the artistic rendering of motion, which, together with the laws on the combination of colours, have at all times been unconsciously followed by the great masters.

A cultivated and artistically gifted eye, supported by sufficient technical knowledge, was always able to compose genuine works of art in photography, as Mrs. Cameron long ago proved. In our days, Dr. Vianna de Lima has shown how this branch of art has been advanced and extended by instantaneous photography. It contributes a solution to Conti's question in Lessing's "Emilia Galotti"—whether Raphael, had he been born without hands, would not the less have been the greatest of painters. The photographic plate has been described as the true retina of the philosopher; and one might add, of the artist, if it were not unluckily almost colour-blind. Unfortunately, theoretical reasons which experience will hardly contradict render it highly improbable that the expectations still entertained by artists and the general public, with regard to photography in natural colours, will ever be realized.

Whether photography does not act unfavourably on the reproductive arts, such as engraving, lithography, and woodcutting, by taking their place to an increasing extent, remains to be proved. Its fidelity is certainly such as, in a certain sense, to lower the value of the original drawings of old masters, by making them common property. An exhibition, arranged by one of our art-dealers several years ago, of the best engravings of the "Madonna della Sedia," together with a photograph from the original, first opened our eyes to the extent to which each master has embodied in his copy his own individual conception. But even were photography to cause such a retrogression in the reproductive arts, of what importance would that be, compared to the immeasurable services which, as a means of reproduction itself, it renders art, by disseminating the knowledge and enjoyment of artistic work of all kinds and periods? No one can fully estimate and appreciate what it has done to beautify and enrich our life, whose memory does not reach back into those, as it were, prehistoric times, "when man did not yet travel by steam, write and speak by lightning, and paint with the sunbeam."

Is it credible, after all this, that there can be any need of mentioning the benefits derived by art from the study of anatomy? Has not the "Gladiator" of the Palazzo Borghese given rise to the conjecture that there were anatomical mysteries among the Greek artists, as the only means by which they could have obtained such complete mastery of the nude? Was it not through incessant anatomical studies that Michael Angelo acquired the knowledge necessary for the unprecedented boldness of his attitudes and foreshortenings, which are still a source of admiration to anatomists such as Prof. Henke and Prof. von Brücke? Has not provision been made by all Governments that methodically encourage art, to afford to students an opportunity of training the eye on the dead subject to note what they will have to distinguish under the living skin? Have not three successive teachers, who afterwards became members of this Academy, been intrusted with this important duty in Berlin? Finally, do we not possess excellent compendiums of anatomy specially adapted to the use of artists?

And yet the most renowned English art critic of the day, who in his country enjoys the reputation and veneration of a Lessing, and who lays down the law with even more assurance—Mr. John Ruskin—explicitly forbids his pupils the study of anatomy in his lectures on "The Relation of Natural Science to Art,"[1] given before the University of Oxford. Even in the preface he deplores its pernicious influence on Mantegna and Dürer, as contrasted with Botticelli and Holbein, who kept free from it. "The habit of contemplating the anatomical structure of the human form," he continues, "is not only a hindrance but a degradation, and has been essentially destructive to every school of art in which it has been practised." According to him, it misleads painters, as for instance Dürer, to see and represent nothing in the human face but the skull. The artist should "take every sort of view of animals, in fact, except one—the butcher's view. He is never to think of them as bones and meat."

It would be waste of time and trouble to refute this false doctrine, and to set forth what an indispensable aid anatomy gives to artists, without which they are left to grope in the dark. It is all very well to trust one's own eyes, but it is better still to know, for instance, how the male and female skeleton differ; why the kneecap follows the direction of the foot during extension, and not during flexion of the leg; why the profile of the upper arm during supination of the hand differs from that during pronation; or how the folds and wrinkles of the face correspond to the muscles beneath. Campe's facial angle, though superseded for higher purposes by Prof. Virchow's basal angle, still reveals a world of information. It is hardly conceivable how, without knowledge of the skull, a forehead can be correctly modelled, or the shape of a forehead such as that of the "Jupiter of Otricoli" or the "Hermes" be rightly understood. Of course fanciful exaggeration of anatomical forms may lead to abuse, as is frequently the case with Michael Angelo's successors; however, there is no better remedy against the Michael Angelesque manner than earnest study of the real. Finally, a superficial knowledge of comparative anatomy helps artists to avoid such errors as an illustrious master once fell into, who gave the hind-leg of a horse one joint too many; or such as amuses naturalists in the crocodile of the Fontaine Cuvier near the Jardin des Plantes, which turns its stiff neck so far back that the snout almost touches the flank.

We are, however, less surprised at Mr. Ruskin's opinions, on learning that he similarly prohibits the study of the nude. It is to be confined to those parts of the body which health, custom, and decency permit to be left uncovered, a restriction which certainly renders anatomical studies somewhat superfluous. It is satisfactory to think that decency, custom, and health allowed the ancient Greeks more liberty in this respect. Fortunately, the English department of the Berlin International Exhibition four years ago has convinced us that Mr. Ruskin's dangerous paradoxes do not yet generally prevail, and that we are free to forget them in our admiration of Mr. Alma Tadema's and Mr. Herkomer's paintings. Nor could Mr. Walter Crane's charming illustrations, the delight of our nurseries, have been produced without disregard of Mr. Ruskin's preposterous doctrine.

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[1] Nature, vol. xlii. pp. 151 and 197.

[1] "The Eagle's Nest: Ten Lectures on the Relation of Natural Science to Art," 1887.

In the same lecture Mr. Ruskin opposes with the utmost vehemence the theory of evolution and natural selection, and the æsthetic rule founded on it, according to which vertebrate animals should not be represented with more than four legs. "Can any law be conceived," he says, "more arbitrary, or more apparently causeless? What strongly planted three-legged animals there might have been! what systematically radiant five-legged ones! what volatile six-winged ones! what circumspect seven-headed ones! Had Darwinism been true, we should long ago have split our heads in two with foolish thinking, or thrust out, from above our covetous hearts, a hundred desirous arms and clutching hands, and changed ourselves into Briarean Cephalopoda."

Obviously, this false prophet has no notion of what in morphology is called a type. Can it be necessary to remind a countryman of Sir Richard Owen and Prof. Huxley that the body of every vertebrate animal is based on a vertebral column, from which it derives its name, expanding at one end into a skull, reduced to a tail at the other, and surrounded before and behind by two bony girdles, the pectoral and the pelvic arches, from which depend the fore and hind limbs with their typical joints? The very fact that palæontology has never known any form of vertebrate animal to depart from this type is in itself a striking argument in favour of the doctrine of evolution, and against the assumption of separate acts of creation; there being no reason why a free creative Power should have thus restricted itself. So little will Nature deviate from the type once given, that even deformities are traced back to it by teratology. They are not really monstrosities; not even those with a single eye in the middle of the forehead, which Prof. Exner takes to be prototypes of the Cyclops, Flaxman being certainly mistaken in representing Polyphemus with three eyes—two normal ones which are blind, and a third in the forehead. Real monstrosities are those winged shapes of Eastern origin, invented by a riotous fancy while art was in its childhood: the bulls of Nimrûd, the Harpies, Pegasus, the Sphinx, the griffin, Artemis, Psyche, Notos of the Tower of Winds, the goddesses of Victory, and the angels of Semitic-Christian origin. A third pair of extremities, (Ezekiel even admits a fourth) is not only contrary to the type, but also irrational in a mechanical sense, there being no muscles to govern them. In the "Fight with the Dragon," Schiller has happily avoided giving his monster the usual pair of wings; and in Retzsch's illustrations its shape agrees so far with comparative anatomy as to recall a Plesiosaurus or Zeuglodon returned to life and changed into a land animal; indeed, the resemblance between those animals and the mythical dragon has led to the question whether the first human beings might not have actually gazed upon the last specimens of those extinct animal races.

An abomination closely related to the winged beasts are the Centaurs, with two thoracic and abdominal cavities, and a double set of viscera; the Cerberus and Hydra, with several heads on as many necks; and the warm-blooded Hippocamps and Tritons, whose bodies, destitute of hind limbs, end in cold-blooded fish—an anomaly which already shocked Horace. If they had at least a horizontal tail fin, they might pass for a kind of whale. The cloven-footed Faun is less intolerable; from him our Satan inherited his horns, pointed ears, and hoofs, on account of which Cuvier, in Franz von Kobell's witty apologue, ridicules him as an inoffensive vegetable feeder. The heraldic animals, such as the double eagle and the unicorn, have no artistic pretensions, and their historical origin entitles them to an indulgence they would otherwise not deserve.

It is a remarkable instance of the flexibility of our sense of beauty that, though saturated with morphological principles, our eye is no longer offended by some of these monstrosities, such as the winged Nike and the angels; and it would perhaps be pedantic, certainly ineffectual, to entirely condemn these traditional and more or less symbolical figures, though in fact the greatest masters of the best epochs have made very slight use of them. There are, however, limits to our toleration. Giants, as they occur in our Gigantomachia, with thighs turning half-way down into serpents, which consequently rest, not upon two legs, but upon two vertebral columns ending in heads and endowed with special brains, spinal cords, hearts, and intestinal canals, special lungs, kidneys, and sense-organs—these are, and always will be, the abhorrence of every morphologically trained eye. They prove that, if the sculptors of Pergamon surpassed their predecessors of the Periclean era in technical skill, they were certainly second to them in artistic refinement. Perhaps they should be excused on the plea that tradition bound them to represent the giants with serpent legs. The Hippocamps and Tritons, with horses' legs and fish-tails, which disfigure our Schlossbrücke, date from a period in which classical taste still reigned supreme, and morphological views were still less widely diffused than at present. Let us therefore pardon Schinkel for designing or at least sanctioning them, as well as the winged horse and griffin on the roof of the Schauspielhaus, for which he must also be held responsible. But our indignation is justly aroused when a celebrated modern painter depicts with crude realism such misshapen male and female monsters wallowing on rocks, or splashing about in the sea, their bodies ending in fat shiny salmon, with the seam between the human skin and the scaly cover scantily disguised. Such ultramarine marvels are worshipped by the crowd as the creations of genius; then what a genius Höllen-Breughel must have been!

Curiously enough, the inhabitants of the caves of Périgord, the contemporaries of the mammoth and musk-ox in France, and the bushmen whose paintings were discovered by Prof. Fritsch, only represented as faithfully as possible such animals with which they were familiar; whereas the Aztecs, a people of comparatively high civilization, indulged in fancies of more than Eastern hideousness. It would almost appear as if bad taste were associated with a middle stage of culture.

With regard to the teaching of anatomy in schools of art, the above proves that it should not be confined to human osteology, myology, and the doctrine of locomotion alone, but that it should also endeavour—and the task is not difficult—to familiarize the student with the fundamental principles of vertebral morphology.

Botanists should in their turn point out such violations of the laws of the metamorphosis of plants as must, no doubt, frequently strike them in the acanthus arabesques, palmettos, rosettes, and scrolls, handed down to us from the ancients. From obvious reasons, however, these cannot affect them as painfully as malformations of men and animals, being in themselves repulsive to natural feelings, would the comparative anatomist. Moreover, a beneficial revolution has recently taken place in floral ornament. The displacement of Gothic art by the antique during the Renaissance had led to a dearth of ideas in decorative art. The rich fancy and naïve observation of nature, displayed upon the capitals of many a cloister, had gradually given way to a fixed conventionalism, no longer founded on reality. Rauch, at Carrara, in search of a model for the eagles on his monuments, was the first to turn to a golden eagle, accidentally captured on the spot, instead of to one of the statues of Jupiter. It was then that, towards the middle of the century, decorative art began to shake off its fetters, and, combining truthfulness with beauty, returned to the study and artistic reproduction of the living plants with which we are surrounded. In this respect the Japanese had long ago adopted a better course, and to them we have since become indebted for many suggestions. Thus highly welcome additions were made to the decoration of our homes, and the ornaments of female dress.

In one direction, however, it will be observed that men of science readily dispense with a strict observation of the laws of nature in art, at the risk of being charged with inconsistency. In works of art, both ancient and modern, flying and soaring figures occur in thousands. These, no doubt, sin against the omnipotent and deeply felt laws of gravity quite as much as the most loathsome creations of a depraved imagination against the principles of comparative anatomy, familiar only to a few adepts. Nevertheless they do not displease us. We prefer them without wings, because wings are contrary to the type, and could be of no use to them without an enormous bulk of muscle. But we do not mind the Madonna Sistina standing on clouds, and the subordinate figures kneeling on the same impossible ground. "Ezekiel's Vision" in the Palazzo Pitti is certainly less acceptable. But to quote modern examples, Flaxman's "Gods flying to the aid of the Trojans," or Cornelius's Apocalyptical riders, and Ary Scheffer's divine Francesca di Rimini, with which Doré had to enter into hopeless competition, are not the less enjoyable because they are physically impossible. We do not even object to Luini's representing the corpse of St. Catharine carried through the air by angels, or to that of Sarpedon, in Flaxman's drawing, by Sleep and Death.

In an interesting lecture on the "Physiology of Flying and Soaring in the Fine Arts," Prof. Exner endeavours to explain why illustrations of men and animals in this condition, though impossible and never visible in real life, strike us as familiar and natural. I do not profess to agree entirely with the solution which he appears to prefer. His idea is, that our sensations in swimming, and the position in which we see persons above us in the water when diving, are similar to what we would experience in flying. Considering what a short time the art of swimming has been generally practised by modern society, especially by ladies, who nevertheless appreciate flying figures just the same, doubts arise as to the correctness of Prof. Exner's explanation. To attribute the feeling to atavism in a Darwinian sense, dating from a fish-period in the development of man, seems rather far-fetched. And do not the sensations and aspect of a skater come much nearer to flying or soaring than those of a swimmer?

Another remark of Prof. Exner, which had also occurred to me, appears more acceptable. It is, that under especially favourable bodily conditions we experience in our dreams the delicious illusion of flying. For

> "in each soul is born the pleasure
> Of yearning onward, upward, and away,
> When o'er our heads, lost in the vaulted azure,
> The lark sends down his flickering lay,
> When over crags and piny highlands
> The poising eagle slowly soars,
> And over plains and lakes and islands
> The crane sails by to other shores."[1]

Who would not long, like Faust, to soar out and away towards the setting sun, and to see the silent world bathed in the evening rays of eternal light far beneath his feet? And when we long for anything, we love to hear of it, and to see it brought before us in image. Our desire to rise into the ether, and our pleasure in "Ascensions" and similar representations, are further enhanced by the ancient belief of mankind in the existence of celestial habitations for the blessed beyond the starry vault; a belief which Giordano Bruno put an end to, though not so thoroughly but that we are constantly forgetting how badly we should fare, were we actually to ascend into those vast, airless, icy regions, which even the swiftest eagle would take years to traverse before alighting on some probably uninhabitable sphere.

We are now inclined to reverse the question, and to ask: What have sculpture and painting been able to do for science in return for its various services? With the exception of external work, such as the representing of natural objects, not much else than the results obtained by painters as to the composition and combination of colours, which, however, have not exercised as strong an influence on chromatics as music on acoustics. It is known that the Greeks possessed a canon of the proportions of the human body, attributed to Polycletes, which, as Prof. Merkel recently objected, unluckily only applied to the full-grown frame, to the detriment of many ancient works of art. The blank was not systematically filled up till the time of Gottfried Schadow. This canon has since become the basis of a most promising branch of anthropology—anthropometry in its application to the human races.

If the definition of art were stretched so far as to include the power of thinking and conceiving artistically, then indeed it would be easy enough to find relations and transitions between artists and philosophers, though, as we remarked at the beginning, their paths diverge so completely. But it is not so certain that natural science would necessarily be benefited by an artistic conception of its problems. The aberration of science at the beginning of this century known as German physio-philosophy owed its origin quite as much to æsthetics as to metaphysics, and the same erroneous principles guided Goethe in his scientific researches. The artistic conception of natural problems is in so far defective, as it contents itself with well-rounded theoretical abstractions, instead of penetrating to the causal connection of events, to the limits of our understanding. It may suffice in cases where analogies are to be recognized by a plastic imagination between certain organic forms, such as the structure of plants or vertebrate animals; but it fails altogether in subjects such as the theory of colours, because it stops short at the study of what are supposed to be primordial phenomena, instead of analyzing them mathematically and physically. Prof. von Brücke subsequently, by the aid of the undulatory theory, traced to their physical causes the colours of opaques on which Goethe founded his theory of colours, and which to this day have tended rather to darken than to enlighten certain German intellects. The difference between artistic and scientific treatment becomes very evident in this example.

Nevertheless, it cannot be denied that artistic feeling may be useful to scientific men. There is an æsthetic aspect of experiment which strives to impart to it what we have termed mechanical beauty; and no experimenter will regret having responded to its demands as far as was in his power. Moreover, the transition from a literary to a scientific epoch in the intellectual development of nations is accompanied by a tendency to brilliant delineation of natural phenomena, arising from the double influence of the setting and the dawning genius. Instances thereof are Buffon and Bernardin de Saint-Pierre in France, and Alexander von Humboldt in Germany, who, to his extreme old age, remained faithful to this tendency. In the course of time, this somewhat incongruous mixture of styles splits into two different manners. Popular teaching preserves its ornamental character, while the results of scientific research only claim that kind of beauty which in literature corresponds to mechanical beauty. In this sense, as I long ago ventured to indicate here on a similar occasion, a strictly scientific paper may, in tasteful hands, be made as finished a piece of writing as a work of fiction. To strive after such perfection will always repay the trouble to men of science; for it is the best means of testing whether a chain of reasoning, embracing a series of observations and conclusions, is faultlessly complete.

And this kind of beauty, which often graces, unconsciously and unsought for, the utterances of genius, will no doubt be also found to adorn Leibnitz's writings.

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[1] Translation of Goethe's "Faust," by Bayard Taylor.